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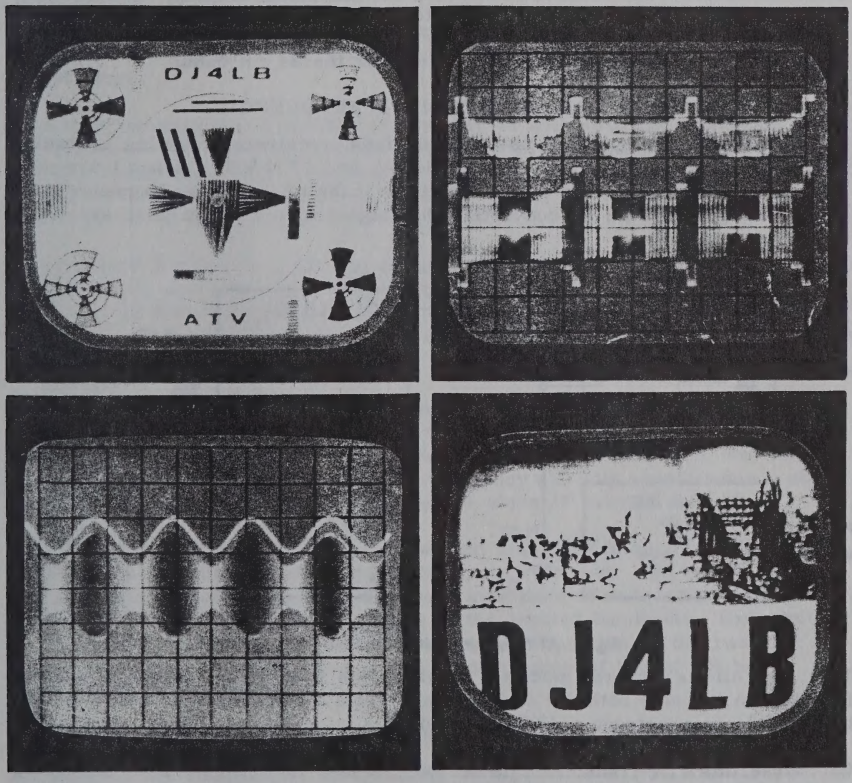
A MODULAR ATV TRANSMITTER



A MODULAR ATV TRANSMITTER

by G. Sattler, DJ 4 LB

The following article is to describe the low-power modules of an amateur television transmitter for the 70 cm band. The transmitter is of modular construction and the modules can also be used for other purposes such as a converter or voice transmitter. Since the linearity and the bandwidth of the 70 cm module has been designed for television (A 5) modulation, it will also be suitable for use with any other operating mode permissible on the 70 cm amateur band. Details are to be given on how the modules can be used as an SSB-converter, FM-transmitter and how the frequency plan can be modified for use on the inactive frequencies on the whole 70 cm band, which is 10 MHz and not just 2 MHz in bandwidth.

1. CONCEPT

As was mentioned in (1), it is advantageous to inject the sound carrier at IF-level. In this case the video and sound signals are modulated onto intermediate frequency carriers that are then converted in a common mixer to the required frequency on the 70 cm band. It is also possible for the signal to be converted further so that transmissions are possible on the 24 cm band.

1.1. SELECTION OF THE INTERMEDIATE FREQUENCY

The intermediate frequencies used in television receivers operating according to the CCIR standard of 38.9 MHz (video) and 33.4 MHz (sound) are also favourable for transmission if the selectivity at the intermediate frequency level and the image rejection on converting this signal to the 70 cm band are taken into consideration.

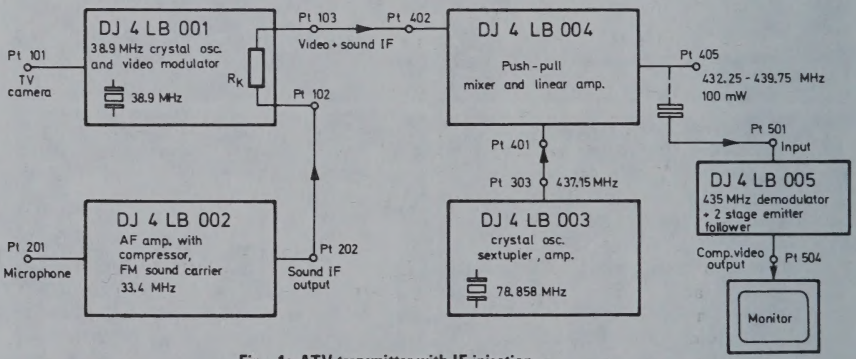


Fig. 1: ATV transmitter with IF injection

This also allows several modules, such as the UHF local oscillator and the IF chain to be used both for transmit and receive, which means that it would be possible to construct a ATV-transceiver.

Of course, this ATV-transmitter is not only suitable for transmissions according to the CCIR standard since it is easily possible to change the spacing between video and sound carriers and since the video signal is dependent on the com-

posite video signal fed into the transmitter from the camera. This means that the transmitter can be used for virtually all television standards.

1.2. LIST OF MODULES, FREQUENCY PLAN

The individual modules of the low-power ATV transmitter are given in Fig. 1 in the form of a block diagram:

Module DJ 4 LB 001 provides the video IF signal at 38.9 MHz as well as the 33.4 MHz signal injected from DJ 4 LB 002. These signals are converted to the 70 cm band in module DJ 4 LB 004 with the aid of the local oscillator frequency of 473.15 MHz generated in module DJ 4 LB 003. The video carrier will then be available at 434.25 MHz, and the sound carrier at 439.75 MHz.

The monitor circuit DJ 4 LB 005 is used to demodulate the UHF signal to obtain the composite video signal for monitoring purposes, since this allows the actual transmitted UHF signal to be monitored and not just the input video signal.

1.3. SIDEBAND SUPPRESSION

A residual sideband filter can be connected between the video IF output and the input of the mixer. The sound IF bypasses the filter and is added in the output stage.

It is recommended that a residual sideband filter with switchable bandpass characteristics be used that is combined with the receive portion. Due to the adjustable bandwidth, which is reduced with respect to that given in the CCIR television standard and by use of separate traps, it is possible for a 70 cm FM repeater to be used simultaneously.

The transmit frequencies of the active and planned 70 cm repeaters in the range of 438.6 MHz and 439.1 MHz results in video frequencies in the range of 4.35 MHz to 4.85 MHz after beating with the TV video carrier. However, they can be suppressed by decreasing the bandwidth without noticeable loss of resolution (1).

It is also possible for TV transmissions to be made without residual sideband filter since the frequency plan used for the sound carrier frequency does not cause a second sound carrier to be transmitted outside of the 70 cm amateur band, e.g. at 428.75 MHz. This image frequency will only appear when a sound subcarrier of 5.5 MHz is modulated to the video IF frequency.

In addition to this, the frequency conversion and amplifier circuits of module DJ 4 LB 004 and the subsequent amplifier stages (e.g. with tubes EC 8020, 2 C 39) will noticeably suppress the lower sidebands when tuned to a frequency between the video and sound carrier due to the limited bandwidth. Experiments at the receive end has shown that only a very low portion of the radiated frequency spectrum is transmitted in the voice portion of the 70 cm band (432.1 MHz to 433.5 MHz).

1.4. OPERATING VOLTAGE, OUTPUT POWER

All modules are designed for an operating voltage of 12 V (11 V to 13 V). An output power of approximately 100 mW composite video and sound signal is available for feeding a 70 cm antenna or for driving a linear amplifier.

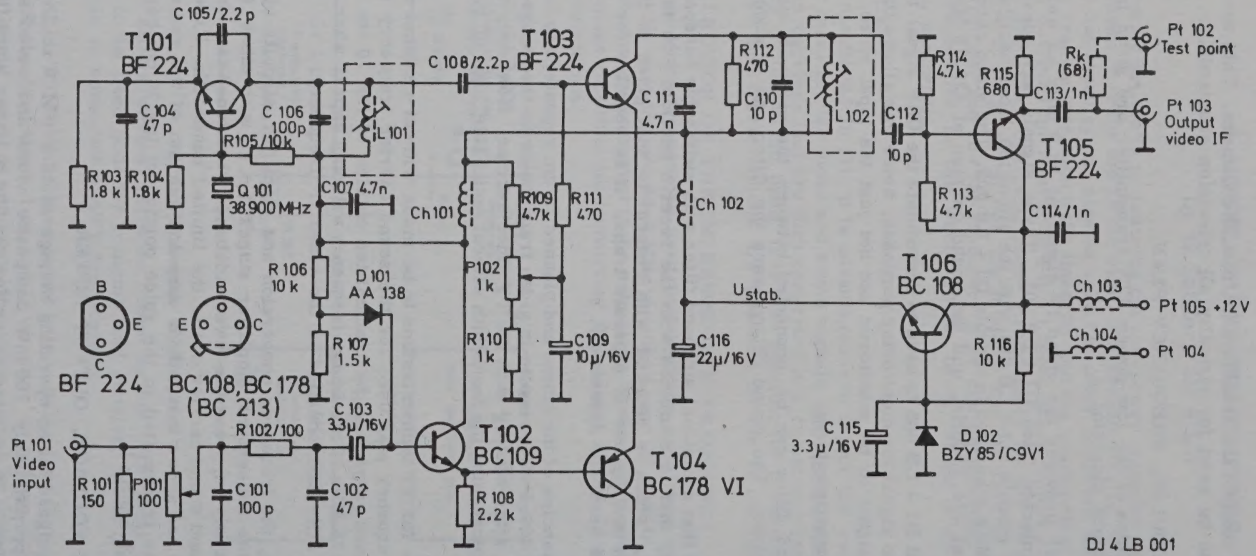


Fig. 4: Circuit diagram of the video IF module DJ 4 LB 001

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1.5. MECHANICAL CONSTRUCTION

All modules are built up on single-coated PC boards. The dimensions of modules DJ 4 LB 001 to 004 are 135 mm x 50 mm, and are suitable for installation into a TEKO box size 4B. Printed circuit board DJ 4 LB 005 is only 60 mm x 50 mm and fits into a TEKO-2B box.

The modular construction in individual metal boxes ensures correct operation and avoids RF injection from the transmitter.

2. VIDEO IF MODULE DJ 4 LB 001

As can be seen in the block diagram of module DJ 4 LB 001 given in Figure 2, the video intermediate frequency is generated in a crystal-controlled oscillator. This ensures a high frequency stability and ensures that the video carrier fre-

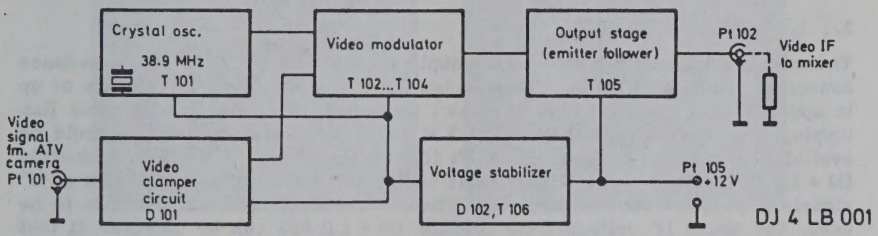


Fig. 2: Block diagram of the video-IF module DJ 4 LB 001

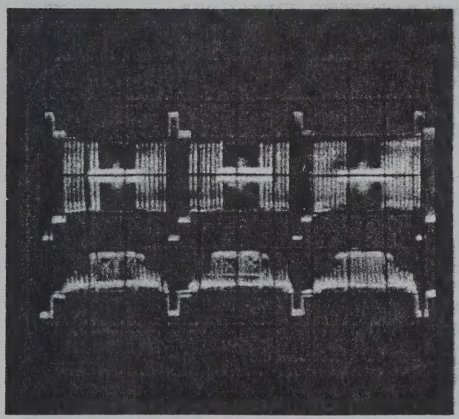


Fig. 3: IF envelope (above) and composite video signal (below)

quency is not affected by the modulation. The amplitude modulator circuit has been especially designed for composite video signals. It differs from conventional AF modulators in that its frequency bandwidth is from approximately 20 Hz to 6 MHz and that the negative modulation is made with the aid of a clamping circuit. The reasons for using negative amplitude modulation were mentioned in (1). With negative modulation, the lower the modulation level, the greater will be the output carrier level, and vice versa. The peak output power

of the video carrier signal is present when no video modulation is fed to the transmitter, and not the mean value as would be the case during voice transmissions. Figure 3 shows a photograph of the IF-envelope (38.9 MHz) as well as the composite video signal (below).

2.1. CIRCUIT DETAILS

The circuit diagram of module DJ 4 LB 001 is given in Figure 4. The overtone crystal oscillator (T 101) operates at 38.9 MHz. The oscillator is loosely coupled to the amplifier stage (T 103) via the low capacitance of C 108. The emitter of the amplifier stage T 103 is modulated with the video signal. Trimmer potentiometer P 102 adjusts the operating point of the amplifier stage by varying the base bias voltage and can therefore be used for adjusting the IF output voltage. The subsequent IF resonant circuit comprising L 102/C 110 is dampened by resistor R 112 in order to achieve the required bandwidth.

2.1.1. OUTPUT STAGE

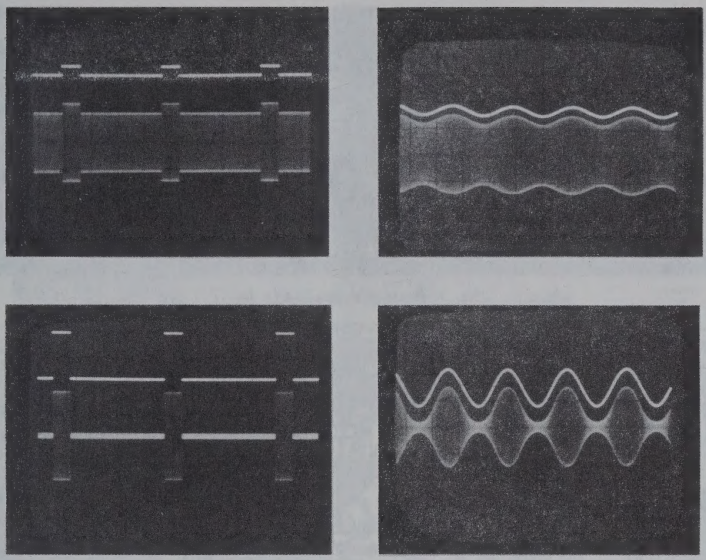
The modulated IF voltage is fed via coupling capacitor C 112 to the impedance converter transistor T 105. The selected dimensioning allows RF signals of up to approximately 0.9 V (peak-to-peak) to be fed to a 60 Ω load without flat-topping. An IF voltage of between 0.3 V and 0.6 V (peak-to-peak) should be available at the output connection Pt 103 which is fed to the mixer module DJ 4 LB 004 with the aid of a coaxial cable. The injection or extraction of IF signals is possible over resistor R_c. When no residual sideband filter is to be used, the sound IF voltage from module DJ 4 LB 002 can be injected at test point Pt 102.

2.1.2. INPUT CIRCUIT FOR THE COMPOSITE VIDEO SIGNAL

The composite video signal from the television camera or a pattern generator (2) is fed to the input connection Pt 101. The parallel connection of P 101 and R 101 forms an input impedance of 60 Ω. Potentiometer P 101 allows the input voltage of the modulator to be adjusted and thus the depth of modulation. A lowpass filter comprising components C 101, R 102 and C 102 suppress any RF signals picked up between the composite video input and the modulator.

2.1.3. CLAMPER CIRCUIT

A constant, positive bias voltage is fed from the voltage divider R 106/R 107 to the base of transistor T 102. The clamper diode D 101 ensures, in conjunction with C 103, that the base voltage of T 102 is only driven into the positive voltage range. Diode D 101 will conduct when any negative modulation pulses are present and the forward current will charge C 103 until the original, positive bias voltage is obtained. The negative-going synchronizing pulses of the composite video signal are therefore based on this bias voltage and are clamped to a constant value. The base voltage of transistor T 102 has a direct relation to the IF level due to the DC coupling to transistor T 103. This means that the clamper circuit ensures that the synchronizing pulses always possess the same peak-to-peak value in the IF-envelope independent of whether the total composite video signal has a value of 0.5 V (black image) or 1.4 V (white image). The oscilloscope traces given in Fig. 5a/b and Fig. 6a/b show the operation of the clamping circuit in the presence of squarewave, and sinusoidal modulating signals. This means that the ATV transmitter radiates synchronizing pulses of the same power level which are virtually independent of the level of the video signal.



Figs. 5 and 6: Operation of the clamping circuit

2.1.4. NEGATIVE MODULATION

The series connection of transistors T 103 and T 104 is fed from the impedance converter T 102 with the clamped modulation signal. A high base voltage at T 104 will have the effect of a low current in the series circuit and thus a low IF output level, and vice versa. This circuit provides the negative modulation so that the IF envelope signal is obtained from the composite video signal.

The interconnection of the emitters of T 103 and T 104 is at IF voltage, since no bypass capacitors are provided. The differential resistance of transistor T 104 (RF feedback) is thus operative during the modulation process and linearizes the modulation characteristic.

2.1.5. VOLTAGE STABILIZATION

Due to the high value of the base bias resistor T 116, the simple voltage stabilizer circuit (T 106, D 102) is capable of being short-circuited. Capacitor C 115 suppresses any noise voltage generated by the zener diode which can occur, especially, at low currents. The stabilized voltage is used for feeding the crystal oscillator and modulator stages. The adjusted value will remain even when connecting to different operating voltages.

2.2. CONSTRUCTION

As has been previously mentioned, this module is accommodated on a single-coated PC-board whose dimensions are 135 mm by 50 mm. The PC-board for the video IF module is designated DJ 4 LB 001; it can be accommodated in a

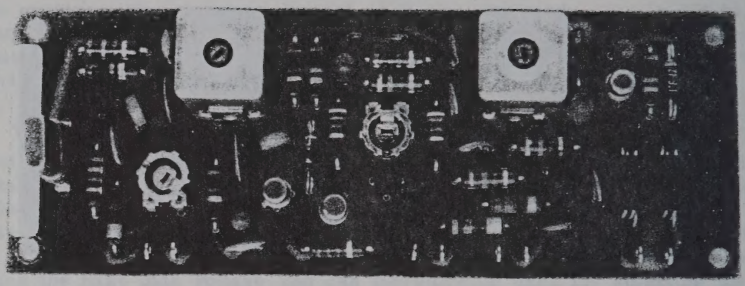


Fig. 7: Prototype module DJ 4 LB 001

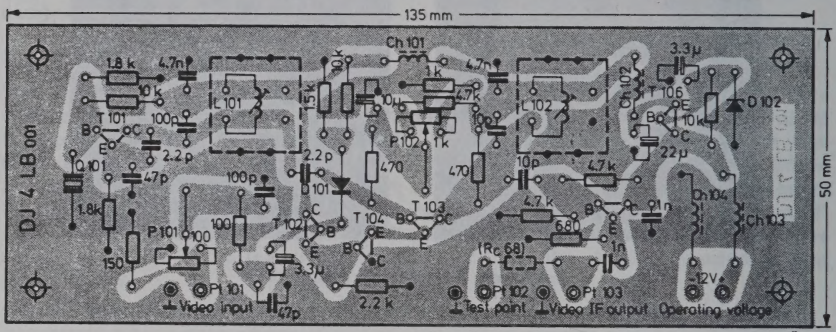


Fig. 8: PC-board and component locations of DJ 4 LB 001

TEKO-box size 4B. It has been necessary to use the higher boxes due to the height of the screening cans. The PC-board can be mounted with the aid of screws using spacing bushings or nuts in order to obtain a spacing of approx. 5 mm to the base of the box. As can be seen from the photograph of the prototype given in Figure 7, all connection pins are located on the long side of the printed circuit board. After installation into the TEKO-box, sufficient room is provided on this side for plug-in connections and/or coaxial connectors and feedthrough capacitors. The PC-board and the component locations are shown in Figure 8. Sufficient room is given on the PC-board so that even older, larger capacitors and resistors can be used.

2.2.1. SPECIAL COMPONENTS

T 101: BF 224, BF 173
T 102: BC 109, BC 184 or similar
T 103: BF 224, BF 173
T 104: BC 178 VI, BC 213 (PNP)
T 105: BF 224, BF 173
T 106: BC 108 or similar
D 101: AA 138, AA 112, AA 116 germanium diode
D 102: BZY 85/C9V1 (9.1 V zener diode)

L 101: 5.75 turns of 0.8 mm dia. (20 AWG) silver-plated copper wire wound on a 5 mm dia. coilformer, coil length 8 mm, facing the collector side of the PC-board. Special coil kit.

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*Transmitting equipment sold only to licensed radio amateurs verified in the Callbook for legal purposes. If newly licensed or upgraded, send copy of license. Receiving downconv. available to all starting @$49 (TVC-2G).

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Any Tech class or higher amateur can get on 70cm, novices now on 23cm ATV. Any video camera, camcorder, VCR or computer with a composite video output can be plugged into the front panel 10 pin VHS jack or rear panel phono jacks for both audio & video.

DX with TC70-1s and KLM 440-27 antennas line of sight and snow free is about 22 miles, 7 miles with the 440-6X normally used for portable uses like parades, races, search & rescue, damage assessment, etc. For greater DX or punching thru obstacles add either the ATV compatible 15 or 50 watt amplifiers listed below.

The TC70-1 has full bandwidth for color & sound, like broadcast. You can show the shack, home video tapes, computer programs, repeat SSTV, weather radar, or even Space Shuttle video if you have a home satellite receiver. See the *ARRL Handbook* chapt. 20 & 7 for more info & *Repeater Directory* for local ATV repeaters.

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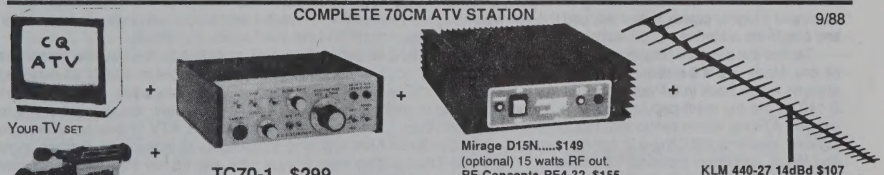

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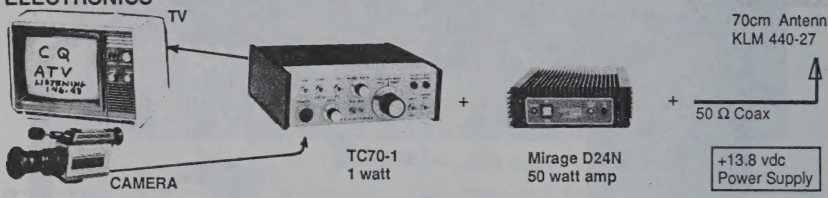
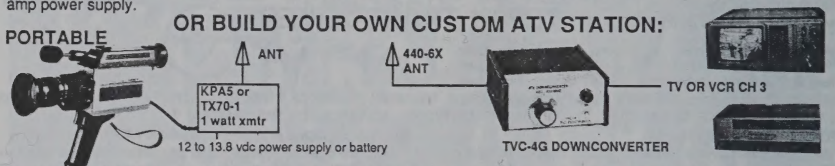
READY TO GO ATV STATION



THIS IS THE QUICKEST AND EASIEST WAY TO GET ON ATV AND ENJOY THE FUN!

Connect up your TV set tuned to ch 2,3 or 4 to the TC70-1 TV output for receiving, plug in your camera, VCR, or computer video and audio for transmitting. With 1 watt and KLM 440-27 antennas (assumes 3 db coax loss) at each end the snow free line of sight DX is 22 miles. The smaller 440-6X at one end, usually for portable work, gives half (6db less gain) the distance. For greater DX or non line of sight conditions (usually over 15 miles) add the Mirage 50 watt amp for up to 154 miles. The TC70-1 and camera can be run off a Radio Shack 22-124 power supply or all units from a regulated 13.8vdc 12 amp power supply.

OR BUILD YOUR OWN CUSTOM ATV STATION:



Run portable ATV like you would a HT, but when back at the base station or mobile, you could plug it into the 50 watt amp for greater DX. Truly the most versatile for cordless home video taping, public service work, or general ATV contacts. Snow free portable line of sight DX with a ground plane on the KPA5 and an Isopole omni at the receive end is 2.5 miles, 11 with a 440-6X antenna. Connect the output of a TC70-1, TVC-4G, or TVCX-70 downconverter to your TV set or VCR tuned to channel 2, 3 or 4, which ever is open in your area, to receive. It's easy!

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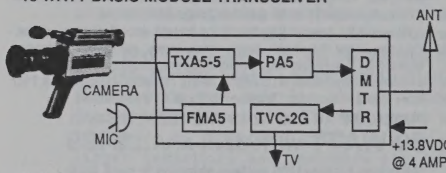
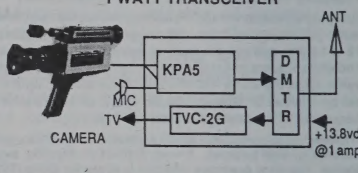


1 WATT TRANSCEIVER



Build your own ATV transceiver using the standard 10 watt set of modules as described in ch 20 of the 1987 ARRL Handbook, and if higher power is desired, add the 100 watt Mirage D1010N-ATV. A small 1 watt transceiver can also be built up and amplifiers added to run 50 watts. For more info on video see chapt 7 in the 1987 ARRL Handbook.

To find out the ATV frequencies in your area check the ARRL Repeater Directory, or call us to find out who else might be on. Many use a 2 meter FM simplex calling frequency to not only initiate the ATV contacts but to enable all receiving stations to talk back in full duplex to the video transmitting station who is talking on the sound subcarrier. 144.34, 144.91 & 146.43 are the most popular, check to see what is used in your area. With an omni on 2 meters you should be able to get any ATVers within range that would take beams on 70cm. The 2 meter channel makes ATV interactive with more stations, easier to tell if there is activity, better for talking in beam headings, fine adjustments to video level, camera angle and focus, and other technical information. You will find that putting most of your time and money into a good antenna system will pay off the most. Since trees and other foliage attenuate 70cm RF greatly, the antenna must be up as high as possible. The RF horizon for a 50ft tower is only 10 miles. Use good 50Ω tight braid coax, weather proof and take great care in putting together the connectors.

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RETURN POLICY. All sales are final once shipped by us. Any returns of unused equipment are subject to a 15% shipping, handling, retesting & restocking charge if the purchaser calls us for authorization within 15 days of our shipping date. Unused in this case means never connected up in anyway, no physical damage, or in our opinion completely resaleable as new.

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Address _____
City_____ State_____ Zip_____
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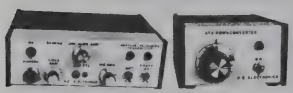
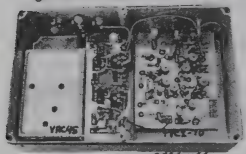
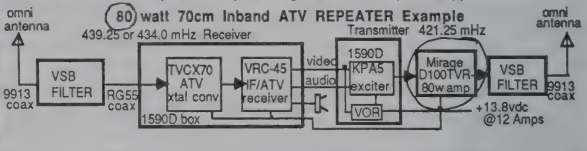


The **TX23-1** is a one watt p.e.p. all in one box, ready to go, television transmitter crystaled for 1289.25, **$299**. See page 4. Use any home video camera, camcorder, VCR, computer that has a composite video output. For receiving, connect up the new **TVC12G ($109)** downconverter to the built in RF T/R relay. Add your TV set tuned to ch 7 or 8, 23cm antenna and you are on!

BASIC 70CM ATV REPEATER SYSTEM

Put together your own 80 watt inband repeater system using the modules listed in the block diagram below or go crossband by substituting the RTX-33 or 23 xmtr modules and antennas. The receiver boards are mounted in a Hammond 1590D diecast aluminum box. Another 1590D is used for the 1 watt transmitter and VOR board. An excellent vestigial sideband filter/duplexer with only 1.6 db insertion loss is available from TX/RX Systems [call Jon: (716)-5494700] - run one good antenna. For more info send a self addressed stamped envelope asking for our ATV repeater application note.





TVCX-70 CRYSTAL CONTROLLED ATV DOWNCONVERTER.....$99
Sensitive GaAsfet preamp & mixer. Specify input frequency & 45.75 MHz output.

VRC45 45.75 MHz IF/ATV RECEIVER MODULE.....$99
Outputs: 2 videos, line & speaker audio, S-meter. Squelched audio. 12Vdc. Mount in Hammond 1590D ($17) with TVCX-70 or TVCX-33 for complete repeater receiver.

VOR VIDEO OPERATED RELAY. Detects horizontal sync to key repeater.....**$25**
Mount in Hammond 1590D box ($17) with KPA5 on 421.25 MHz for repeater exciter.

***NEW* ELKTRONICS VDG-1 VIDEO IDENTIFIER AND COLOR BAR GENERATOR BOARD.....$89**
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TVX-1 10 WATT COMMUNITY TV TRANSMITTER (Export only)
Rack panel (3.5x19") 10 watt p.e.p. TV transmitter intended for community TV outside the USA & Canada. Continuous duty. Accepts composite video & line level audio from a home satellite receiver, VCR, or camera. NTSC or PAL compatible. Requires 120 Vac 60 Hz or 13.8 Vdc @ 3 amps. 50 ohm N connector antenna output. 100 watt p.e.p. amplifiers ($550) and transmit 50Ω omni antennas ($350 ch 3-13) also available. Typical application: subscribers receive 426.25 MHz on ch 3 with our TVC-4G downconverter ($89) & KLM 440-6X ($51) antenna. Not licensable in USA & Canada. All orders require a written statement that "The TVX-1 will not be used in the USA, but will be used in (give city and country)". Also give name and address of responsible party in foreign country. Prices are delivered UPS surface to your freight forwarder or agent in cont. USA.

(All TVX transmitters take 2 to 6 weeks delivery after receiving paid order and statement. None are off the shelf as each is made special to your specified channel). **UHF** ch 14 thru 20 or 380 to 512 MHz ....**$650**, **VHF** ch3 thru 13 .....**$750**

NOTES:

SEE US IN PORTLAND!

L 102: 13.75 turns of 0.3 mm dia. (29 AWG) enamelled copper wire close-wound, otherwise as L 101.

Ch 101, Ch 102: Ferrite bead on insulated wire.
Ch 103, Ch 104: Ferrite choke Z = 800 Ω (6-hole ferrite core, 6 mm dia., 10 mm long, Philips 4321 020 36700)

Crystal: 38.900 MHz HC-25/U with holder (vertical) or HC-6/U without holder.

Trimmer potentiometer: For horizontal mounting, spacing 5 mm/10 mm.

A spacing of 12.5 mm is available for all resistors.

All electrolytic capacitors: Tantalium drop types for 2.5 mm spacing.

All other capacitors: Ceramic disc types for 5 mm spacing.

2.3. ALIGNMENT OF MODULE DJ 4 LB 001

The coarse alignment is made without composite video signal. Potentiometer P 102 should now be adjusted to its fully right stop in order to obtain the highest base bias voltage for transistor T 103. The crystal oscillator is designed so that it is not able to oscillate at any other frequency than the resonant frequency of the crystal. The core of L 101 is now slowly rotated from its fully inserted position until the oscillator commences oscillation and the IF-voltage can be measured at connection Pt 103. After the point of maximum IF-voltage has been found, the core should be rotated slightly more out of the coil for reasons of stability until the IF output falls to 70% to 50% of the maximum value. After this, L 102 should be aligned for maximum IF-voltage output. Due to the damping of the circuit, the resonance will not be very sharp. Potentiometer P 102 should now be adjusted to a range by which the IF output voltage is reduced when the potentiometer is rotated in an anticlockwise direction (towards a lower base voltage). The fine alignment is made with the aid of a composite video signal from a TV-camera. Potentiometer P 101 is firstly placed in its centre position. The IF output voltage can be injected into the last IF amplifier of a TV-receiver if a test demodulator is not available. If the image is distorted, this will probably be caused by compressed or clipped synchronizing pulses. The operating point of the modulator is adjusted with potentiometer P 102 until no distortion of the image is noticeable. Since good TV-receivers will provide perfect images even when the synchronizing pulses are distorted, attention should be paid to the reproduction of the various grey tones of the test signal. If the various monochrome values cannot be differentiated as far as the brightness is concerned, this will mean that the modulation signal (which can be adjusted with potentiometer P 101) is still too great.

3. SOUND IF MODULE DJ 4 LB 002

As can be seen in the block diagram given in Figure 9, module DJ 4 LB 002 consists of the IF sound carrier oscillator and the preamplifier/dynamic compressor for frequency modulation of this oscillator. The combining of these two units to form one module avoids any difficulties that could occur when using an external preamplifier whose behaviour, for instance, with respect to the frequency response or rejection of UHF signals may not be known. A dynamic compressor is provided in the preamplifier in order to compensate for audio voltage fluctuations so that a virtually constant frequency deviation of the sound signal is obtained.

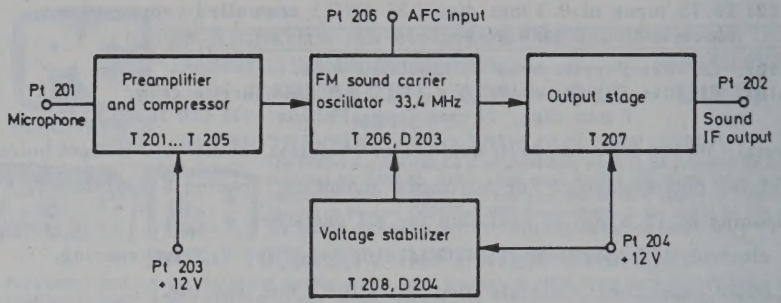

Fig. 9: Block diagram of the sound-IF module DJ 4 LB 002

3.1. CIRCUIT DETAILS

The circuit diagram of this module is given in Figure 10. The operation of this module is now to be explained step for step.

3.1.1. PREAMPLIFIER

The preamplifier comprising transistor T 201 is designed for low-impedance, dynamic microphones of approximately 200 to 500 Ω. The output voltage of this transistor is fed via R 206, C 209 and C 210 to the high impedance input of a three-stage amplifier. The operating point of the DC-coupled transistors T 203, T 204 and T 205 is stabilized via a feedback link comprising R 214, C 211 and R 211.

3.1.2. MEASURES TAKEN AGAINST UHF INTERFERENCE

A combination of UHF-chokes, feedback and short-circuit paths (Ch 201, C 203, C 204) ensure that any UHF voltages are not amplified and demodulated. The $\lambda/4$ choke Ch 202 in the emitter lead of transistor T 203 operates as feedback for UHF voltages which would otherwise affect the amplifier due to the high transit frequency of the silicon AF transistors used.

3.1.3. DYNAMIC COMPRESSION

A positive control voltage is obtained from the AF voltage at the collector of transistor T 205 by rectification in the voltage doubler circuit comprising diodes D 201 and D 202. This influences the internal impedance of transistor T 202 which forms a AF-voltage divider together with resistor R 206. The control voltage will increase with increasing AF output voltage. As soon as the forward voltage of the base emitter diode of T 202 is reached, base current will commence flowing and the collector-emitter path of this transistor will represent a low resistance. Due to the voltage division, the AF level at the collector of T 202 and thus at the input of the subsequent amplifier stage will fall. The filter link comprising C 208, R 207 and C 207 ensures that the amplifier does not break into oscillation and also has an effect on the time constant of the control circuit which is extraordinary short (approx. 100 ms).

The dynamic compression reduces voltage differences having a ratio of 1 to 100 (0.2 mV to 20 mV) at the input to a ratio of approximately 1 to 2.5 at the output of the amplifier.

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